

18



Europäisches Patentamt

European Patent Office

Office européen des brevets

11 Publication number:

0 211 471  
B1

12

## EUROPEAN PATENT SPECIFICATION

45 Date of publication of patent specification: 22.08.90

51 Int. Cl.<sup>5</sup>: D 21 F 7/08

71 Application number: 86300410.7

72 Date of filing: 21.01.86

54 Laminated spiral mesh papermakers fabric.

30 Priority: 08.07.85 US 752911

43 Date of publication of application:  
25.02.87 Bulletin 87/0945 Publication of the grant of the patent:  
22.08.90 Bulletin 90/3444 Designated Contracting States:  
AT BE CH DE FR GB IT LI LU NL SE56 References cited:  
EP-A-0 171 891  
DE-A-3 147 115  
FR-A-2 494 318  
FR-A-2 494 319  
US-A-3 613 258  
US-A-4 528 23673 Proprietor: Asten Group, Inc.  
999 West Valley Road P.O. Box 100  
Devon Pennsylvania 19333 (US)72 Inventor: Finn, William A.  
110 Windsor Court  
Summersville, S.C. 29843 (US)  
Inventor: Searfass, Harry I.  
1382 Anthony Wayne Drive  
Wayne, PA 19087 (US)74 Representative: Williams, Trevor John et al  
J.A. KEMP & CO. 14 South Square Gray's Inn  
London WC1R 5EU (GB)

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

## Description

The disclosed fabric is intended for use in the papermaking industry and finds application in the forming, wet press and dryer section of the papermaking equipment. The fabric is a carrying or conveying means used in the production of paper and is intended for use in applications requiring either a circular woven or a flat woven fabric. In the papermaking industry, fabrics of the present invention, when used in the wet press or dryer section, are frequently referred to as felts since they generally comprise a carrier fabric, which runs in contact with the equipment, and a felt surface, which runs in contact with the paper. Likewise, fabrics used in the forming section are frequently referred to as Fourdrinier wires or simply wires and the forming section of the papermaking process is frequently referred to as the Fourdrinier section or equipment.

It has been recognized in the prior art that it is desirable to provide a felt for use in papermaking machinery comprising an under layer made of relative rigid non-deformable material having a compressible felt layer thereon. The under layer is generally expected to provide a desired void volume for receiving and carrying off water removed from the paper sheet. For example, as the fabric with the paper sheet thereon passes between the nip rollers in the press section, the felt is compressed and water is transferred from the paper sheet to the felt. This water is intended to migrate through the felt and to be voided through the voids provided in the under layer.

The prior art, has recognised that a felted surface used in combination with an adder layer having a predetermined and controlled void volume may be utilised to provide a felt having relatively fine fibres for contacting the sheet of paper to be processed. US Patents 3 613 258, 4 119 753, 4 283 454 and 4 356 225 are representative of prior art attempts to control void volume.

In the forming section it has also been recognised that a high void volume or permeability in the base fabric is highly desirable. However, due to the nature of the papermaking process it is essential that the forming wire or fabric retain the fibrous material in the slurry while permitting rapid drainage of the fluid. One prior art attempt to produce a laminated non-woven papermakers Fourdrinier wire is disclosed in US Patent 3 121 660.

FR—A—2 494 319 discloses a papermakers fabric in accordance with the precharacterising portion of claim 1. The invention is characterised in claim 1 and the greater width of portions of the loops of the special strips as compared with the original monofilament diameter provides improved control of variations in the permeability and void volume of the under layer without affecting the manner in which the upper layer is attached thereto. The adhesion of the upper layer to the lower layer is facilitated by the greater width portions.

The upper fabric may be adhered to the under layer by the selective application of adhesive to the under layer and/or to the upper layer or may be achieved by including meltable adhesive means within the upper layer. The under layer and the upper layer are unified into a single fabric, such as by the application of heat and pressure efficient to activate the adhesive, and form a single fabric as used in the papermaking equipment.

Our EP—A—0 171 891 is an Article 54(3) publication which does not disclose the advantageous requirement of the present invention for the upper layer to have a 10 to 48% open area.

## Brief description of the drawings

Figure 1 is a top plan fragmentary view of an under layer of fabric showing a plurality of intermeshed spiral strips, each of the spirals having modified mid-sections.

Figure 2 is a section which depicts a side elevational view of a fabric similar to that of Figure 1 but in which only the portions of the strips forming the upper surface of the under layer have modified mid-sections.

Figure 3 is an illustrative drawing showing a non-woven upper layer which may be applied to the fabric of Figure 1.

Figure 4 is an illustrative drawing showing the non-woven upper layer of Figure 3 as applied to the under layer.

With reference to Figure 1, there is shown an under layer or base fabric generally referenced as 2. The under layer or base fabric 2 is comprised of a plurality of intermeshed spiral strips 4 which are retained in the intermeshed condition by a plurality of pintles 10. Each of the spiral strips 4 is a monofilament comprised of a plurality of spirals 6. Formation of spiral strips 4 will be discussed in more detail hereinafter. Each of the spirals 6 is comprised of an upper face 8(a), a lower face 8(b) and connecting links 8(c). In the embodiment shown in Figure 1, upper face 8(a) and lower face 8(b) are modified and have a surface width greater than the connecting links 8(c). The modification of upper face 8(a) and lower face 8(b) result in a fabric having reduced void volume and/or permeability. Depending upon the degree of control desired, both the upper and lower face may be modified as shown in Figure 1 or only a single face may be modified. If only a single face is to be modified, it is generally preferred to modify the upper face 8(a) as this is the portion of the fabric which will be closest to the paper supporting surface.

It will be appreciated that the monofilament of spiral strip 4 is rigid or incompressible and not easily deformed in the fabric.

With respect to formation of the spiral strips and the upper formation of upper and lower faces 8(a) and 8(b), which may be formed after the formation of the spiral strips, equipment for each of these purposes is available from EHVAK Maschinen GmbH, Niederröder Weg 10, 6056 Heusenstamm, West Germany.

In order to form the under layer or base fabric 2, the desired number of spiral strips 4 are positioned adjacent each other such that the link portion 8(c) of the spirals on one spiral strip are intermeshed with their counterparts on another spiral strip in order to form a pintle receiving passage. A pintle 10 is then inserted into the passage and retains the spiral strips 4 in the fabric construction. In general, the length of upper face 8(a) and lower face 8(b) will be controlled so as to permit the respective links 8(c) of the adjacent spiral strips to interlace without interference resulting from the modification of the monofilament. It will be appreciated that the permeability of the fabric in that portion where the links 8(c) are intermeshed and the pintle is located will generally be less than that for the remainder of the fabric. The degree of modification of the upper face and lower face will reflect considerations regarding the void volume and permeability in the intermeshed area of the fabric. As noted previously, in certain applications, it may be desirable to eliminate one of the faces 8(a) and 8(b).

With reference to Figure 1, it can be seen that an open mesh 12 is defined in the fabric between adjacent faces 8(a) and between the opposed links 8(c) of the respective spiral steps. As will be appreciated by those skilled in the art, a fabric having spiral strips with faces 8(a) and 8(b) will define similar open mesh areas on either face of the fabric. For those fabrics having only a single face 8(a) or 8(b) the open mesh 12 will be different on the respective faces of the fabric.

With reference to the permeability of the fabric 2, it will be appreciated by those skilled in the art that the desired permeability will vary with machine design and end use applications. However, it is estimated that the finished fabric will generally be between 1130 litres per minute (40 cubic feet per minute) and 7080 litres per minute (250 cubic feet per minute) for dryer fabric applications and between 283.2 and 2832 litres per minute (10 and 100 cubic feet per minute) for wet or press felt applications. Permeability for forming fabrics may be as high as 28320 litres per minute (1000 cubic feet per minute) and will be discussed in more detail hereinafter.

Those skilled in the art will further understand that the fabric layer 40 of Figure 2, will influence and contribute to the final permeability.

In the United States testing is generally in accordance with ASTM D 737-75 (reapproved 1980) on equipment such as the Frazier Air Permeability Tester, available from Frazier Precision Instrument Company, 210 Oakmont Avenue, Gaithersburg, Maryland. The ASTM standard entitled "Standard Test Method for Air Permeability of Textile Fabric" fully describes the test and its variations and is incorporated herein by reference as if fully set forth. However, such standards for air permeability are known throughout the world and the relative difference between and among the various fabrics is known to those skilled in the art.

With reference to Figure 2, there is illustrated a section view of a fabric similar to that of Figure 1. The spirals 6 in their portions forming the upper surface of the under layer have a major axis M and a minor axis m and a diameter d. Figure 3 graphically depicts the intermeshing of the links 8(c) of adjacent spiral strips 4 and the location of the pintle 10.

Figure 2 clearly shows the reduced void volume or permeability of the intermeshed pintle area and likewise depicts the voids 20 which may be modified by means of filler strands 22 to control the void volume and/or permeability.

Further, with reference to Figures 1 and 2, it will be appreciated by those skilled in the art that the void volume and permeability of the fabric may be modified by various combinations of open mesh 12 and modified void volumes 20.

An upper layer is adhered to the under layer or base fabric 2 by means of selective application of an adhesive layer to the under layer or base fabric. The application of the adhesive to under layer 2 may be made uniformly or by random application of the adhesive. Examples of adhesives suitable for application in the instant invention are Scotch Grip, an Epoxy available from 3M Company, Esthane, a urethane available from B. F. Goodrich and RTV Series Silicones, available from General Electric.

It is further to be appreciated that the adhesive must be applied with such care as to prevent adhesion of the spirals 6 and/or the adhesion of spiral strips 4. To obtain the full advantages of the invention, the under layer or base fabric 2 must retain its flex characteristics within the finished felt. Excessive adhesion of spiral strips 4 may lead to under desired running characteristics and performance qualities.

In an alternative method, the adhesive layer could comprise a sprayed adhesive or a fusible film or a laminated layer which is applied to the under layer fabric 2. Suitable films may be formed of fusible polyethylenes, polypropylenes, polyamids, polyesters, and urethanes. Furthermore, it will be appreciated by those skilled in the art that the extent to which adhesive layer extends over the surface of the fabric will depend upon the adhesive selected and the required adhesion. As a further alternative, it is possible to adhere the fabrics by use of a resin treatment which is applied to the under layer fabric 2 to reduce its permeability. The use of a resin treatment to establish adhesion will be known to those skilled in the art.

With reference to Figures 1 and 2, it will be appreciated that the diameter of the monofilament will affect the width of the faces 8, 8(a), and 8(b). Since it is desirable to have the links 8(c) in a touching or nearly touching relationship, the width, w, of the faces 8(a) and 8(b) is limited as a practical matter to twice the diameter, d, of the monofilament, thus  $w=2d$ . This condition when combined with the touching or near touching of the links 8(c) would, in effect, close off the space available between the individual spirals 6 and

produce the maximum reduction in permeability. As the fabric is designed for greater permeability this relationship may be relaxed. With respect to the maximum length of the faces 8, 8(a), and 8(b), the length (L) may generally be expressed by the formula: maximum length (L) equals the major axis (M) minus twice the selected pintle diameter (p), plus four times the diameter of the monofilament (d) or

$$L = M - (2p + 4d).$$

With respect to use of the invention in the forming area of the papermaking equipment, it will be noted that the under layer and the control of the permeability or drainage characteristics thereof will be in accordance with the above description related to Figures 1 and 2. As will be recognized by those skilled in the art, the economics of papermaking generally dictate that the fabrics used in the forming area will have maximum litres per min (CFM) or maximum drainage of fluids from the furnish which is applied to the fabric; likewise, it is desired to have maximum fiber retention in the forming area. As is known in the art, the ability to remove maximum fluid while retaining maximum fiber in the forming area results in reduced cost of drying the paper in subsequent sections of the papermaking equipment and also reduces the amount of fiber which is lost into the pans of the forming area and into the white water. It will also be recognized by those skilled in the art that virgin fiber will generally have a more controlled fiber length than may be present in reclaimed fiber. Likewise, those skilled in the art will recognize that the size of the interstices in the forming fabric must be selected in consideration of the fiber length contained in the furnish and the desired drainage and fiber retention characteristics of the fiber. It is understood by those skilled in the art that there is not a direct correlation between permeability and drainage. Depending upon weave construction and the number of layers in the fabric, it is possible to obtain the same drainage factor with fabrics having different permeabilities. This results from the method of testing air permeability which may be reduced by certain fabric constructions providing essentially the same void volume for drainage, but providing it in a more tortured path which results in reduced air permeability readings.

It is generally accepted that fibre retention in the area of 60 to 80% may be satisfactory for certain applications. Accordingly, fibre retention in excess of 80% is generally considered to be an improvement.

In view of the desire of those skilled in the art to obtain maximum drainage and fibre retention, it has been suggested to use duplex and triplex fabrics in the forming area, however, such fabrics are of a complex weave construction and are generally more expensive than those fabrics used in the prior art.

With respect to permeability of forming fabrics,

it will be recognised by those skilled in the art that the permeability of the forming fabric may vary substantially in accordance with the application of the fabric. In single layer forming fabrics, permeabilities are usually in the range of 16992 to 22656 litres per minute (600 to 800 cubic feet per minute). For tissue paper applications, it is common to have fabrics with a permeability in the range of 19824 to 22656 litres per minute (700 to 800 cubic feet per minute) and for fine papers it is common to have permeabilities in the range of 16992 to 18408 litres per minute (600 to 650 cubic feet per minute). For certain non-paper applications, such as paper board, the permeability may range up to 28320 litres per minute (1000 cubic feet per minute). For two layer fabrics intended for fine papermaking, fabrics as low as 5664 litres per minute (200 cubic feet per minute) has been reported with acceptable drainage characteristics. As can be seen from the foregoing, the permeability may range up to approximately 28320 litres per minute (1000 cubic feet per minute), depending on the application. Likewise, it will be remembered that the size of the fabric interstices, drainage and the desired fibre retention will be dictated by the end use of the fabric and the cost of the fibre as well as the fibre length.

In forming fabrics according to the invention, the under layer or base layer of the fabric is utilized primarily to define the drainage characteristics and the upper layer is used primarily to define the percentage of fiber retention. Additionally, the upper layer will be primarily responsible for establishing the desired surface characteristics for contact with the paper web and the under layer will be primarily responsible for establishing the necessary mechanical strength for running the fabric on the papermaking equipment.

With prior art single layer fabrics, it is common to have open areas in the range of 16 to 48 percent of the total fabric area. For tissue paper applications percent open area in the range of 18 to 25 percent is common and for fine papers open areas of 19 to 35 percent are common. In some applications open area may range as low as about 10 percent and as high as about 50 percent of open area. It will be understood by those skilled in the art that open area generally refers to through apertures or interstices in the final fabric. Thus, if one were to hold the fabric up to a light source, light would shine through the open areas. In some of the duplex and triplex fabrics currently in use there is no open area in this traditional sense. However, drainage is achieved through the indirect paths referred to previously hereinabove. As used hereinafter open area refers to each fabric layer and not to the unitized fabric.

With reference to Figure 3, there is shown a non-woven upper layer for use in a fabric according to the invention. The upper layer 40 of Figure 3 may be a sheet material molded of a number of plastic or synthetic materials such as polypropylene, polyester, teflon or other suitable materials. A sheet of material 42 is provided with a plurality

of apertures 44 which may be cut or punched into the material 42. The size and location of the apertures 44 as well as the number will be determined by the end use. Generally, the opening or interstice of the aperture 44 will be determined by the fiber size in the furnish and the degree of retention desired. Likewise, the number or amount of apertures 44 which are provided in the material will be determined by the percentage open area desired in the final fabric layer. Accordingly, the desired open area will be influenced by the size of the aperture 44, which as noted before will be influenced by the fiber length in the furnish.

It will be understood by those skilled in the art, that a woven fabric of any construction may be substituted for the upper layer 40 depicted in Figure 3. For example, a fine woven fabric utilizing weaves known in the art, such as plain, twill, satin, broken satin, atlas and non-twill weaves may be used. Likewise, the number of sheds utilized in producing the upper layer weaves will be determined by the type of paper being produced. As is known by those skilled in the art, it is frequently desired to limit the amount of wire marking which takes place in the forming section and planar fabrics are generally preferred for this purpose. However, if one did wish to achieve wire marking in the paper for design purposes and the like, the upper layer could be woven to achieve such wire marking. Likewise, it will be understood that designs or patterns may be produced on non-woven upper layers as depicted in Figure 3.

With respect to the upper layer, the essential criteria is to establish the desired fiber retention. The upper layer of the fabric need not exhibit a high degree of mechanical strength, since the under layer fabric will be substantially responsible for providing the mechanical strength necessary to permit the fabric to run on the papermaking equipment. The only criteria with respect to strength in the upper layer is that the upper layer exhibits sufficient strength to permit its adhesion to the base layer during the uniting process and sufficient strength to resist damage from the furnish.

With respect to Figure 4, there is illustrated a non-woven upper layer as depicted in Figure 3 adhered to a base layer in accordance with the invention. The upper layer 40 has been exaggerated in size for the purpose of illustration and it will be recognized that the thickness of the upper layer 40 will only be determined by the required strength characteristics of the material selected and that the thickness thereof does not form any part of this invention. As can be seen, the apertures 44 will permit drainage of the water from the furnish while the solid portion 42 of the upper layer will retain the fiber. Likewise, it can be seen that open area in the upper layer need not align with the open area in the under layer.

With reference to Figure 4, the spirals 6 of the under layer are in accordance with the description hereinabove and the under layer may have drainage, permeability and open area characteristics

different than the upper layer. In the instant application it is preferred that the under layer have maximum drainage to permit rapid drainage.

With respect to the application of a woven fabric to the under layer, this may be accomplished in the same manner as depicted in Figure 4. It will be understood by those skilled in the art that the interstices of a woven fabric will correspond to the apertures 44 and that the yarns which form the fabric will correspond to the solid portions 42.

With respect to the dryer position of the papermaking equipment, it will be recognized that the fabric depicted in Figure 4 will be suitable for use at that position. By providing an upper layer 40 with the desired permeability such as between 1133 to 9912 litres per min. (40 to 350 CFM), one may achieve maximum fabric contact with the paper sheet while utilizing an under layer which provides maximum support for the upper layer. By forming the under layer in accordance with Figure 1 one achieves maximum surface area for adhesive of the upper layer, maximum sheet contact on the drying equipment and reduced permeability of the unitized fabric.

#### Claims

1. An improved papermakers fabric of the type having an under layer (2) of synthetic monofilament yarns and an upper layer (24) which defines the paper carrying surface of the fabric, said under layer and upper layer being retained as a single fabric with the under layer (2) comprising a plurality of intermeshed synthetic monofilament spiral strips (4) which are retained in that relationship by pintle means (10), each of said spiral strips (4) containing a plurality of spiral turns (6) with each of said spiral turns having a major axis (M) and a minor axis (m), the under and upper layers being retained as a single fabric by adhesive means, characterised in that face portions (8a) of at least the upper surface of said spiral turns (6) have a width (W) greater than the diameter (d) of the monofilament comprising the spiral strips, and in that said face portions (8a) have a maximum length defined by the equation maximum length (L) equals the major axis (M) minus (twice the diameter (p) of the pintle means plus four times the diameter (d) of the monofilament) or

$$L = M - (2p + 4d),$$

and in that said upper layer has a percent open area which is in the range of 10 to 48% of the total fabric area.

2. A fabric according to claim 1, wherein said face portions (8a) have a width no greater than twice the diameter (d) of the monofilament.

3. A fabric according to claim 1 or 2, wherein face portions (8b) on the lower surface of said spirals have a width greater than the diameter (d) of the monofilament comprising the spiral strips.

4. A fabric according to claim 3, wherein said face portions (8b) on the lower surface of the spirals have a width no greater than twice the diameter (d) of the monofilament.

5. A fabric according to any preceding claim, wherein said under layer has a permeability which is less than 28320 litres per minute (1000 cubic feet per minute).

6. A fabric according to any preceding claim, wherein said under layer has a permeability less than that of said upper layer and has a percent open area which is in the range of 18 to 35% of the total fabric area.

7. A fabric according to any preceding claim, wherein said upper layer is a non-woven layer.

#### Patentansprüche

1. Verbessertes Siebband für Papiermaschinen bestehend aus einer oberen Schicht (24) mit einer das Papier tragenden Oberfläche und einer damit verbundenen unteren Schicht (2) mit einer Vielzahl aus Kunststoffdrähten hergestellten Wendeln (4), die durch Steckdrähte (10) ineinandergreifend zusammengehalten werden und die jeweils aus einzelnen Windungen mit einer großen Achse (M) und einer kleinen Achse (m) bestehen, wobei die obere Schicht (24) und die untere Schicht (2) durch Haftmittel zu einem einzigen Siebband miteinander verbunden sind, dadurch gekennzeichnet, daß die Außenflächen (8a) wenigstens der oberen Windungsschenkel (8) der Windungen (6) eine Breite (W), die größer ist als der Durchmesser (d) des Kunststoffdrahtes der Wendeln (4) und eine maximale Länge (L) aufweisen, die sich ergibt aus der maximalen Länge der großen Achse (M) vermindert um den (doppelten Durchmesser (p) der Steckdrähte vermehrt um den vierfachen Durchmesser (d) des Kunststoffdrahtes) oder

$$L = M - (2p + 4d),$$

und daß die obere Schicht eine teilweise offene Fläche in der Größenordnung von 10 bis 48% der gesamten Siebbandfläche aufweist.

2. Siebband nach Anspruch 1, dadurch gekennzeichnet, daß diese Außenflächen (8a) eine Breite aufweisen, die nicht größer ist als der zweifache Durchmesser (d) des Kunststoffdrahtes.

3. Siebband nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Außenflächen (8b) der unteren Windungsschenkel der Windungen eine Breite aufweisen, die größer ist als der Durchmesser (d) des Drahtes der Wendeln.

4. Siebband nach Anspruch 3, dadurch gekennzeichnet, daß die Außenflächen (8b) der unteren Windungsschenkel eine Breite aufweisen, die nicht größer ist als der zweifache Durchmesser (d) des Kunststoffdrahtes.

5. Siebband nach den Ansprüchen 1 bis 4, dadurch gekennzeichnet, daß die untere Schicht eine Durchlässigkeit von weniger als 28320 l pro min. (1000 Kubikfuß pro min.) aufweist.

6. Siebband nach den Ansprüchen 1 bis 5, dadurch gekennzeichnet, daß die untere Schicht eine geringere Durchlässigkeit als die obere Schicht und eine teilweise offene Fläche in der Größenordnung von 18 bis 35% der gesamten Siebbandfläche aufweist.

7. Siebband nach den Ansprüchen 1 bis 6, dadurch gekennzeichnet, daß die obere Schicht eine nicht gewirkte Schicht ist.

#### Revendications

1. Tissu perfectionné pour papeterie du type ayant une sous-couche (2) de fils monofilaments synthétiques et une couche supérieure (24) définissant la surface porteuse de papier du tissu, lesdites couches supérieure et inférieure étant maintenues comme un seul tissu, la couche inférieure (2) comportant plusieurs bandes (4) de spirales en monofilaments synthétiques entrelacées qui sont maintenues ainsi par des joncs (10), chaque bande (4) de spirales comprenant plusieurs spirales (6), chacune desdites spirales ayant un grand axe (M) et un petit axe (m), les couches supérieure et inférieure étant maintenues comme un seul tissu par des moyens adhésifs, caractérisé en ce que les parties en surface (8a) d'au moins la surface supérieure desdites spirales (6) ont une largeur (W) plus grande que le diamètre (d) du monofilament des bandes de spirales et en ce que lesdites parties en surface (8a) ont une longueur maximale définie par l'équation de la longueur maximale (L) égale au grand axe (M) moins (deux fois le diamètre (p) des joncs plus quatre fois le diamètre (d) du monofilament) ou

$$L = M - (2p + 4d)$$

et en ce que ladite couche supérieure à un pourcentage de surface ouverte qui est dans la fourchette de 10 à 48% de la totalité de la surface du feutre.

2. Tissu selon la revendication 1 caractérisé en ce que lesdites portions de surface (8a) ont une largeur pas plus grande que deux fois le diamètre (d) du monofilament.

3. Tissu selon l'une des revendications 1 ou 2 dans lequel les parties de surface (8b) de la surface inférieure desdites spirales ont une largeur plus grande que le diamètre (d) du monofilament comportant les bandes spirales.

4. Tissu selon la revendication 3 dans lequel les parties de surface (8b) de la face inférieure des spirales ont une largeur pas plus grande que deux fois le diamètre (d) du monofilament.

5. Tissu selon l'une des revendications précédentes dans lequel ladite couche inférieure à une perméabilité qui est inférieure à 28 320 litres par minute (1 000 pieds cubiques par minute).

6. Tissu selon l'une des revendications précédentes dans lequel ladite couche inférieure à une perméabilité inférieure à celle de la couche supérieure et un pourcentage de surface ouverte qui

est dans la fourchette de 18 à 35% de la surface totale du tissu.

7. Tissu selon l'une des revendications précé-

dentes dans lequel ladite couche supérieure est une couche non-tissée.

5

10

15

20

25

30

35

40

45

50

55

60

65

7

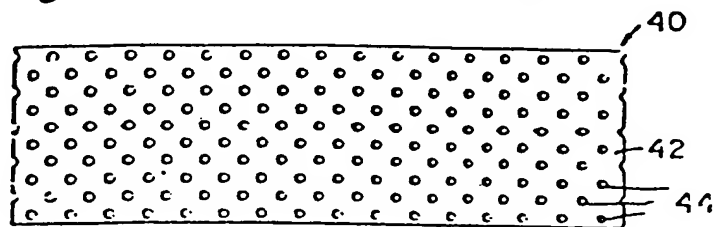
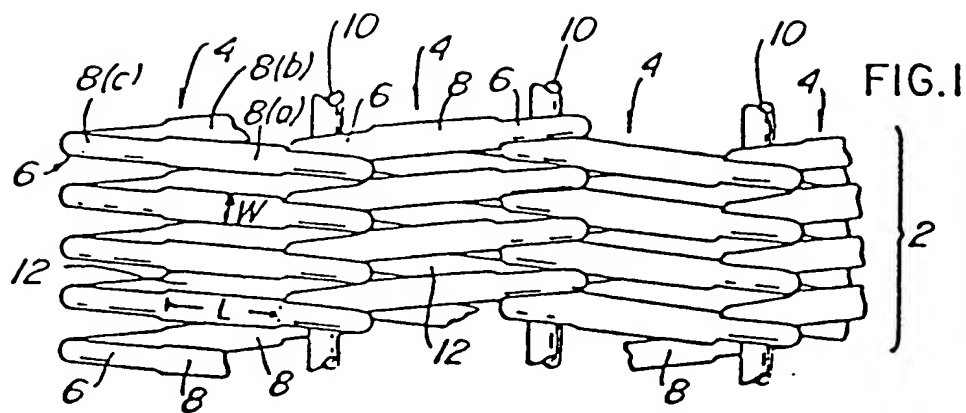


FIG. 3

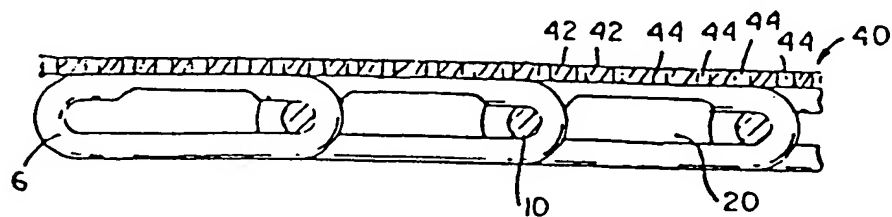
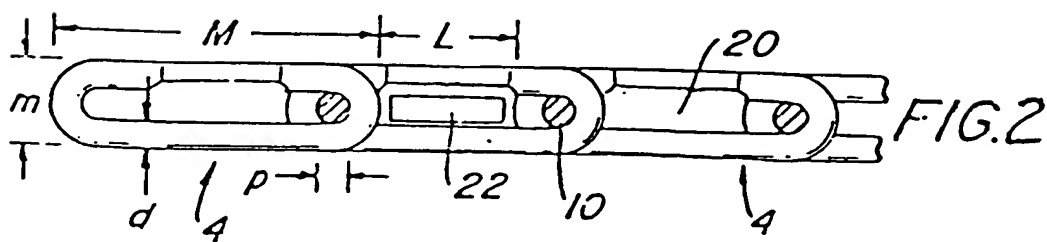


FIG. 4



**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**